Using Clinical Decision Support to Make Informed Patient Care Decisions

September 19, 2008

Presenters:

Jon White, MD
Agency for Healthcare Research and Quality

Richard Shiffman, MD, MCIS
Yale University School of Medicine

Blackford Middleton, MD, MPH, MSc
Partners Healthcare System

Moderator:

Teresa Zayas Cabán, PhD
Agency for Healthcare Research and Quality
Clinical Decision Support Demonstrations

Jon White, MD
Agency for Healthcare Research and Quality
Background

• Clinical decision support has been applied to
  – increase quality and patient safety
  – improve adherence to guidelines for prevention and treatment
  – avoid medication errors

• Systematic reviews have shown that CDS can be useful across a variety of clinical purposes and topics
Definitions

• Shortliffe, 2006: “A computer-based system that assists physicians in making decisions about patient care”

• Dr. Robert Hayward of the Centre for Health Evidence; “Clinical Decision Support systems link health observations with health knowledge to influence health choices by clinicians for improved health care”
Clinical Decision Support

• AMIA CDS Roadmap (2006)
  – “Clinical decision support (CDS) provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care.”

  – CDS encompasses a variety of tools and interventions
    • Computerized alerts and reminders
    • Clinical guidelines
    • Order sets
    • Patient data reports and dashboards
    • Documentation templates
    • Diagnostic support
    • Clinical workflow tools
Barriers

Current adoption of advanced clinical decision support is limited due to a variety of reasons, including:

- Limited implementation of EMR, CPOE, PHR, etc.
- Difficulty developing clinical practice guidelines
- Lack of standards
- Poor support for CDS in commercial EHRs
- Challenges in integrating CDS into the clinical workflow
- Limited understanding of organizational, and cultural issues relating to clinical decision support
AHRQ’s Goals for Advancing Clinical Decision Support

• To facilitate the development, adoption, implementation and evaluation of best practices using CDS.

• To further enhance the nation's efforts to make evidence-based clinical knowledge more readily available to health care providers.
CDS Demonstration Projects

Objective
To develop, implement, and evaluate projects that advance the understanding of how best to incorporate CDS into health care delivery.

Overall goal
Explore how the translation of clinical knowledge into CDS can be routinized in practice and taken to scale in order to improve the quality of healthcare delivery in the U.S.

Funding
$1.25 million per project per year for up to five years
Key Demonstration Goals

• Incorporate CDS into EHRs certified by the Certification Commission for Health IT (CCHIT).
• Demonstrate cross-platform utility.
• Establish lessons learned for CDS implementation across the health IT vendor community.
• Assess potential benefits and drawbacks of CDS.
• Evaluate methods for creating, storing, and replicating CDS elements across multiple clinical sites and ambulatory practices.
• Translate clinical guidelines and outcomes related to preventive health care and treatment of patients with chronic illnesses.
AHRQ Guidelines Into Decision Support (GLIDES)

Richard Shiffman, MD, MCIS
Yale University School of Medicine
A Systematic and Replicable Approach to Development of Ambulatory Decision Support
Overview

• Goals

• Knowledge transformation
  – Define clinical objectives
  – Markup: Guideline Elements Model (GEM)
  – XSL transforms for process documentation
  – Action-types
  – Preview of user interface
Yale New Haven Hospital

• 966 bed tertiary care hospital includes YNHCH and Primary Care Center

• Major teaching affiliate of Yale School of Medicine

• Pediatric Primary Care Center provides care for 8,000 inner-city patients in 28,000 visits annually
• Healthcare system dedicated to children
• >400 MDs and 4100 staff
• Multi-specialty practice sites in
  • Wilmington, DE; PA, NJ;
  • Orlando, Jacksonville, Pensacola
• In 2006, 924,000 encounters
  - 238,569 children received care
Goals of the GLIDES Project

1. Implement evidence-based guideline recommendations that address prevention of pediatric obesity and chronic management of asthma.

2. Apply GEM and its associated tools to systematically and replicably transform the knowledge contained in these guidelines into a computable format.

3. Deliver the knowledge via electronic decision support at ambulatory sites that employ GE’s Centricity EMR at Yale and EPIC’s EpicCare at Nemours.

4. Evaluate the fulfillment of these goals and the effectiveness of the decision support tools in improving the quality of health care.
Project Timeline Overview

**Phase 1 Implementation**
- Asthma
- Yale Specialty

**Phase 2 Implementation**
- Obesity
  - Yale PC
  - Nemours Delaware PC
- Asthma
  - Nemours Orlando
  - Nemours Jacksonville
  - Nemours Pensacola

**Phase 3 Implementation**
- Asthma
  - Yale Primary Care
  - Nemours Delaware

**Evaluation**
- Jan-April 2008
- Mar-June 2008
- June-October 2008
- October 2008 – June 2009
- June-November 2009
Challenge of Representing Guideline Knowledge Electronically

Published Guideline

Computer-Based Guideline Implementation
Translation of Guideline Knowledge for Decision Support

- Collaborators at Stanford, Harvard and Columbia
- Task: Knowledge engineers individually encode guidelines for vaccine administration and for workup of breast mass
- Test: Submit standardized patients
- Outcome: Different recommendations would be given for the same patient

Patel VL. JAMIA 1998
Clinical Objectives
(Osheroff, Sittig, et al. 2005)

• Prevent errors
  – Commission
  – Omission

• Optimize decision making
  – Choice of individual tests or treatments
  – Improve appropriateness of workup/treatment plan

• Improve care processes
  – Improve documentation
  – Improve patient education, empowerment, satisfaction
  – Improve communication among caregivers
Select Relevant Guideline and Recommendations

- Teleconference to define objectives
- 3 criteria
- Pertinent recommendations identified

<table>
<thead>
<tr>
<th>Recognize high-risk behaviors</th>
<th>Addressed by GL</th>
<th>Facilitated by IT</th>
<th>Evaluable</th>
<th>Recommend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen time (TV computers)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1c</td>
</tr>
<tr>
<td>Nutritional</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>179, 186 6</td>
</tr>
<tr>
<td>Lack of exercise</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>179, 186 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Counseling (Energy balance: Nutrition-Activity)</th>
<th>Addressed by GL</th>
<th>Facilitated by IT</th>
<th>Evaluable</th>
<th>Recommend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit sugar sweetened beverages</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1a</td>
</tr>
<tr>
<td>Encourage fruits and vegetables</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1b</td>
</tr>
<tr>
<td>Breakfast daily</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1d</td>
</tr>
<tr>
<td>Limit fast food</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1e</td>
</tr>
<tr>
<td>Encourage family meals</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1f</td>
</tr>
<tr>
<td>Limit portion sizes</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>245 1g</td>
</tr>
</tbody>
</table>

5210: (fruits & vegetables, max screen time, physical activity, juice intake) | Y | Y | Y | 245 1 |
## COGS Checklist


<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overview material</td>
<td>Provide a structured abstract that includes the guideline’s release date, status (original, revised, updated), and print and electronic sources.</td>
</tr>
<tr>
<td>2. Focus</td>
<td>Describe the primary disease/condition and intervention/service/technology that the guideline addresses. Indicate any alternative preventive, diagnostic or therapeutic interventions that were considered during development.</td>
</tr>
<tr>
<td>3. Goal</td>
<td>Describe the goal that following the guideline is expected to achieve, including the rationale for development of a guideline on this topic.</td>
</tr>
<tr>
<td>4. Users/setting</td>
<td>Describe the intended users of the guideline (e.g., provider types, patients) and the settings in which the guideline is intended to be used.</td>
</tr>
<tr>
<td>5. Target population</td>
<td>Describe the patient population eligible for guideline recommendations and list any exclusion criteria.</td>
</tr>
<tr>
<td>6. Developer</td>
<td>Identify the organization(s) responsible for guideline development and the names/credentials/potential conflicts of interest of individuals involved in the guideline’s development.</td>
</tr>
<tr>
<td>7. Funding source/sponsor</td>
<td>Identify the funding source/sponsor and describe its role in developing and/or reporting the guideline. Disclose potential conflict of interest.</td>
</tr>
<tr>
<td>8. Evidence collection</td>
<td>Describe the methods used to search the scientific literature, including the range of dates and databases searched, and criteria applied to filter the retrieved evidence.</td>
</tr>
<tr>
<td>9. Recommendation grading criteria</td>
<td>Describe the criteria used to rate the quality of evidence that supports the recommendations and the system for describing the strength of the recommendations. Recommendation strength communicates the importance of adherence to a recommendation and is based on both the quality of the evidence and the magnitude of anticipated benefits or harms.</td>
</tr>
<tr>
<td>10. Method for synthesizing evidence</td>
<td>Describe how evidence was used to create recommendations, e.g., evidence tables, meta-analysis, decision analysis.</td>
</tr>
<tr>
<td>11. Prerelease review</td>
<td>Describe how the guideline developer reviewed and/or tested the guideline prior to release.</td>
</tr>
<tr>
<td>12. Update plan</td>
<td>State whether or not there is a plan to update the guideline and, if applicable, an expiration date for this version of the guideline.</td>
</tr>
<tr>
<td>13. Definitions</td>
<td>Define unfamiliar terms and those critical to correct application of the guideline that might be subject to misinterpretation.</td>
</tr>
<tr>
<td>14. Recommendations and rationales</td>
<td>State the recommended action precisely and the specific circumstances under which to perform it. Justify each recommendation by describing the linkage between the recommendation and its supporting evidence. Indicate the quality of evidence and the recommendation strength, based on the criteria described in 9.</td>
</tr>
<tr>
<td>15. Potential benefits and harms</td>
<td>Describe anticipated benefits and potential risks associated with implementation of guideline recommendations.</td>
</tr>
<tr>
<td>16. Patient preferences</td>
<td>Describe the role of patient preferences when a recommendation involves a substantial element of personal choice or values.</td>
</tr>
<tr>
<td>17. Algorithms</td>
<td>Provide (when appropriate) a graphical description of the stages and decisions in clinical care described by the guideline.</td>
</tr>
<tr>
<td>18. Implementation considerations</td>
<td>Describe anticipated barriers to application of the recommendations. Provide reference to any auxiliary documents for providers or patients that are intended to facilitate implementation. Suggest review criteria for measuring changes in care when the guideline is implemented.</td>
</tr>
</tbody>
</table>
Identify Obstacles to Implementation

- GuideLine Implementability Appraisal (& eGLIA)
- Provides feedback to guideline authors to anticipate and address obstacles before a draft guideline is finalized
- Assists implementers in guideline selection and targeting attention toward anticipated obstacles
- http://gem.med.yale.edu/glia
Guideline Challenges

• EPR3 (NHLBI’s Asthma 2007) is massive
  – Effort at recording evidence quality and recommendation strength is commendable
  – Redundancies, irregular editing
  – Ambiguity: “Children 0-4”
  – Some choices not mutually exclusive, not exhaustive, not well defined
  – Interference with normal activity: None, Minor limitation, Some limitation, Extremely limited

• Pediatric Obesity 2007 (from AMA, HRSA, CDC, et al)
  – Major methodological deficiencies
    • No recommendation strength
Narrative to Semi-Structured

Narrative Guideline → GEM Cutter

Semi-structured XML file

Quality & Implementability Appraisals
Logical Analysis with Highlighters

- UTI Recommendation 3

  If an infant or young child 2 months to 2 years of age with unexplained fever is assessed as being sufficiently ill to warrant immediate antimicrobial therapy, a urine specimen should be obtained by SPA or bladder catheterization; the diagnosis of UTI cannot be established by a culture of urine collected in a bag. (Strength of evidence: good) Urine obtained by SPA or urethral catheterization is unlikely to be contaminated...
XML: From a small number of discrete colors to an unlimited palette
XML

- Multi-platform, Web-based, open standard
- “Tags” *enclose* and *describe* text
  
  `<inclusion.criterion>hematuria</inclusion.criterion>`

- Human-readable, yet can be processed by machine
- Markup can be performed by non-programmers
GEM

- Knowledge model for guideline documents
- GEM adopted as a standard by ASTM in 2002; GEM II updated and re-standardized in 2006
- Models heterogeneous information contained in guidelines
  - Multi-level hierarchy (>100 elements)
Markup Guideline

- GEM Cutter II
  - Parses guideline text into components of the Guideline Elements Model
  - “GEMifying”
  - Creates XML files
  - Available at http://GEM.med.yale.edu
Semi-Structured to Semi-Formal

Narrative Guideline

Semi-structured

EXTRACTOR Transforms

XML file
Quality & Implementability Appraisals

Statement logic
Coded decision variables & actions
Action-types

Semi-formal

GLIDES PROJECT
Guidelines Into Decision Support

Agency for Healthcare Research and Quality
Advancing Excellence in Health Care • www.ahrq.gov
EXTRACTOR: Decision Variables

• Removed from guideline context and presented in a list.
• Opportunity to judge vagueness, underspecification, and decidability
• Comprehensive list of trigger items for decision support activities
• Measurable starting points for evaluation
### Decision Variables

<table>
<thead>
<tr>
<th>0–4 Years of Age</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rec_1: Cond_1: DV_1</strong></td>
</tr>
<tr>
<td>four or more episodes of wheezing in the past year that lasted more than 1 day and affected sleep</td>
</tr>
<tr>
<td><strong>Rec_1: Cond_1: DV_2</strong></td>
</tr>
<tr>
<td>parental history of asthma</td>
</tr>
<tr>
<td><strong>Rec_1: Cond_1: DV_3</strong></td>
</tr>
<tr>
<td>a physician diagnosis of atopic dermatitis</td>
</tr>
<tr>
<td><strong>Rec_1: Cond_1: DV_4</strong></td>
</tr>
<tr>
<td>evidence of sensitization to aeroallergen</td>
</tr>
<tr>
<td><strong>Rec_1: Cond_1: DV_5</strong></td>
</tr>
<tr>
<td>evidence of sensitization to foods</td>
</tr>
<tr>
<td><strong>Rec_1: Cond_1: DV_6</strong></td>
</tr>
</tbody>
</table>
Categorize Action-types

- Test (Inquire, Examine)
- Monitor
- Conclude
- Prescribe
- Perform Procedure

- Refer/consult
- Educate/counsel
- Document
- Dispose
- Prepare
- Advocate
Action-Type Pattern: 
Prescribe

- Drug information
- Safety alerts (allergy, drug-drug, drug-disease, drug-lab)
- Formulary check
- Dosage calculation
- Pharmacy transmission
- Patient education
- Corollary orders
Narrative Guideline

Semi-structured

Semi-formal

- Statement logic
- Coded decision variables & actions
- Action-types
- Local workflow & barrier analysis (technical, people, organizational)
- Local codes
- Origins/insertions

Formal

- Local EHR scripting language
- User interface design
Knowledge Pipeline
How Decision Support May Be Delivered

- Documentation templates (prompts)
- Relevant data presentation (display of relevant lab when ordering)
- Order creation facilitators (order sets, guided dosing algorithms, calculators)
- Reference information (infobutton)
- Reminder (appropriate care)
- Alerts (drug allergy, interaction, critical test notification)

Static

Dynamic
### Classifying Components of Asthma Severity and Initiating Treatment

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Intermittent</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td></td>
<td>&lt;=2d/aw</td>
<td>&gt;2d/aw</td>
<td>Daily</td>
</tr>
<tr>
<td>Wheezing</td>
<td></td>
<td>&lt;=2d/aw</td>
<td>&gt;2d/aw</td>
<td>Daily</td>
</tr>
<tr>
<td>Chest tightness</td>
<td></td>
<td>&lt;=2d/aw</td>
<td>&gt;2d/aw</td>
<td>Daily</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td></td>
<td>&lt;=2d/aw</td>
<td>&gt;2d/aw</td>
<td>Daily</td>
</tr>
<tr>
<td>Nighttime awakening</td>
<td></td>
<td>&lt;=1m</td>
<td>1-2x/mo</td>
<td>&gt;3-4x/mo</td>
</tr>
<tr>
<td>SABA use (not for EIB)</td>
<td></td>
<td>&lt;=2d/aw</td>
<td>&gt;2d/aw</td>
<td>Daily</td>
</tr>
<tr>
<td>Red. school/play/work</td>
<td></td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Risk of ER visit due to asthma</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Hospitalization due to asthma</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Exacerbations requiring oral systemic corticosteroids</td>
<td>&lt;=1/wk</td>
<td>&gt;2/x/wk</td>
<td>3-4x/wk</td>
<td>&gt;1x/wk</td>
</tr>
</tbody>
</table>

**Document 13**

- Treatment-related adverse effects

**Medication Adverse Effect**
- Thrush
- Palpitations
- Uterinness
- Sleep Disturbances
- Decreased Growth
- Other

**Comments**

[Prev Form (Ctrl+PgUp) | Next Form (Ctrl+PgDn) | Close]
### Relevant Data Presentation

#### Recommended Step for Initiating Therapy

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Step 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interruption Asthma</strong></td>
<td><strong>Step 2</strong></td>
<td><strong>Step 3</strong></td>
<td><strong>Step 4</strong></td>
<td><strong>Step 5</strong></td>
<td><strong>Step 6</strong></td>
</tr>
</tbody>
</table>

**Step down if possible if asthma is well controlled at least 3 months**

**Assess control**

**Step up if needed if asthma is not well controlled**

- Check adherence, inhaler technique, and environmental control
- Consider comorbid conditions

**Step up if needed click here**

**Patient Education, Environmental Control, and Management of comorbidities at Each Step**

* SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute interval as needed. Short course of oral systemic corticosteroids may be needed.

* Caution: Increasing use of SABA or use >2 days a week for symptom relief (not prevention of EIB) generally indicates inadequate control and the need to step up treatment.

---

**GLIDES PROJECT**

Guidelines Into Decision Support

**AHRQ**

Agency for Healthcare Research and Quality

Advancing Excellence in Health Care • www.ahrq.gov
Thank you!

GEM.med.yale.edu/glides

richard.shiffman@yale.edu
AHRQ Clinical Decision Support Consortium

Blackford Middleton, MD, MPH, MSc
Partners Healthcare System
CDS Demonstration Project

Objective
To develop, implement, and evaluate projects that advance the understanding of how best to incorporate CDS into health care delivery.

Overall goal
Explore how the translation of clinical knowledge into CDS can be made routine in practice and taken to scale in order to improve the quality of healthcare delivery in the U.S.

Funding
$1.25 million per project per year for two years.
CDS Consortium: Member Institutions

• Partners HealthCare
• Regenstrief Institute
• Veterans Health Administration
• Kaiser Permanente Center for Health Research
• Siemens Medical Solutions/NextGen
• GE Healthcare
• Masspro
• Oregon Health and Science University
• University of Texas, Houston
The CDS Consortium Primary Goal

To assess, define, demonstrate, and evaluate best practices for knowledge management and clinical decision support in healthcare information technology at scale – across multiple ambulatory care settings and EHR technology platforms.
Six Specific Research Objectives

- Knowledge management lifecycle
- Knowledge specification
- Knowledge Portal and Repository
- CDS Knowledge Content and Public Web Services
- Evaluation
- Dissemination

<table>
<thead>
<tr>
<th>1. Knowledge Management Life Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Knowledge Specification</td>
</tr>
<tr>
<td>3. Knowledge Portal and Repository</td>
</tr>
<tr>
<td>4. CDS Public Services and Content</td>
</tr>
<tr>
<td>5. Evaluation Process for each CDS Assessment and Research Area</td>
</tr>
<tr>
<td>6. Dissemination Process for each Assessment and Research Area</td>
</tr>
</tbody>
</table>
Office of the National Coordinator of Health IT: 2008 Strategic Plan

- ONC’s strategic plan Strategy 1.3.3 is:
  - “Incorporate EHR functionalities into health IT certification that provide clinical decision support at the point of care.”

- Milestone 1.3.3 is:
  - “By 2010, certified EHRs include clinical decision support.”

We are on the right path!
Clinical Focus Areas

- **Diabetes**: Glycemic control including medication management and HbA1c testing and screening for complications.
- **Coronary Artery Disease**: Anti-platelet therapy in high-risk populations.
- **Preventive Care**: Hypertension screening.
Consortium Teams

1. Knowledge Management Lifecycle Assessment Team: This team will conduct surveys and site visits at the CDSC member institutions to assess their clinical decision support activities and practices both before and after the CDSC activities.

2. Knowledge Translation and Specification Team (KTS): This team is charged with selecting guidelines to use in consortium activities and translating these guidelines into the multi-layered knowledge representation format for use in the service and demonstration projects.

3. Knowledge Management Portal and Repository Team: This team will develop and implement collaborative knowledge management tools for use in the development, review, publication, cataloging and archival of knowledge specifications in human and machine readable forms.

4. Vendor Generalization and CCHIT Recommendations Team: This team will assess state-of-the-art methods for clinical decision system support and the results from CDSC best practices development, and make a series of recommendations to vendors, content vendors, and regulatory and certification authorities, about best practices and capabilities for decision support.
Consortium Teams, Cont.

5. **CDS Services Team:** This team will take the decision support knowledge representation and knowledge prepared by the KTS team and develop publicly available web services that implement the content for use in information systems among the CDS Consortium.

6. **CDS Demonstrations Team:** This team, in conjunction with site demonstration teams, will perform analysis, development and implementation of decision support interventions using the content and services developed in the CDS Consortium.

7. **CDS Dashboards Team:** This team will develop performance reporting tools and clinical decision support dashboards so that providers and site clinical quality staff can review adherence to Consortium guidelines.

8. **CDS Evaluation Team:** This team will lead and coordinate evaluation activities across all projects performed by the CDS Consortium.

9. **Dissemination Team:** This team will coordinate sharing and publication of the clinical decision support content and best practices developed by the Consortium.

10. **Joint Information Modeling Team:** This team is a joint subcommittee of the KTS and CDS Services team and coordinates information models and terminology across all Consortium projects.
Workflow Diagram

KM Lifecycle

Assessment

Knowledge Translation and Specification

Execution Services

Models 2

Errors and Gaps Feedback

CDS

Demonstrations

CDS Dashboards

Output Format

Service Definition

Input Format

Recommendations

CCHIT/HITSP

CPG

Recommendations

KM Portal

Lessons 1

Lessons 2

Lessons 3

Lessons for Survey Creation

Errors and Gaps Feedback

Specs

Gaps Feedback

Catalogs (rules and services)

Recommendations

Feedback

Feedback

Evaluation

Dissemination

Lessons for Survey Creation

Suggestions for Survey Creation

Data

Quality Data Elements

Catalog

Gaps Feedback

Recommendations

Recommendations

Feedback

Feedback

Suggestion for Survey Creation

Lessons 1

Lessons 2

Lessons 3
Multilayered model

<table>
<thead>
<tr>
<th>Machine Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract Representation</td>
</tr>
<tr>
<td>Semi-structured Recommendation</td>
</tr>
<tr>
<td>Narrative Guideline</td>
</tr>
</tbody>
</table>

Narrative Recommendation layer
- Narrative text of the recommendation from the published guideline.

Semi-structured Recommendation layer
- Breaks down the text into various slots such as those for applicable clinical scenario, the recommended intervention, and evidence basis for the recommendation.

Abstract Representation layer
- Structures the recommendation for use in particular kinds of CDS tools.
  - A recommendation could have several different artifacts created in this layer, one for each kind of CDS tool.

Machine Executable layer
- Knowledge encoded in a format that can be rapidly integrated into a CDS tool on a specific HIT platform.
  - E.g., rule could be encoded in Arden Syntax.
  - A recommendation could have several different artifacts created in this layer, one for each of the different HIT platforms.

Flexibility and adaptability
- Precision and executability

CDS i consortium

Agency for Healthcare Research and Quality
Advancing Excellence in Health Care • www.ahrq.gov
Knowledge Pack

• For each knowledge representation layer in CDS stack:
  – **Data standard** (controlled medical terminology, concept definitions, allowable values)
  – **Logic specification** (statement of rule logic)
  – **Functional requirement** (specification of IT feature requirements for expression of rule, etc.)
  – **Measure specification** (description of method for CDS impact measurement and report)
Why Multilayered Representation?

- Allows us to balance between the competing requirements for flexibility in representation for various environments and the ability to deliver precise, executable knowledge that can be rapidly implemented
  - For those who can use an available Machine Executable level knowledge artifact, this approach provides for rapid implementation of the guideline
  - For others, it might be more appropriate to use an artifact from the Semi-structured Recommendation or Abstract layers, to create rapidly their own executable knowledge. They can then submit the latter to the KM portal for inclusion as a Machine Executable artifact

- Provides a path to achieve logical consistency from the narrative guideline to the execution layer
Knowledge Artifacts by Layer

- Published Guideline
- Semi-structured Recommendation
- Abstract Rule
- Abstract Order Set
- Executable Rules
- Order Sets in CPOE system
## Complete CDS Knowledge Specification

<table>
<thead>
<tr>
<th>Data</th>
<th>Logic</th>
<th>Function</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-structured</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A complete functional specification to accommodate and facilitate a variety of implementation methods in HIT.
# Complete CDS Knowledge Specification

<table>
<thead>
<tr>
<th>Data</th>
<th>Logic</th>
<th>Function</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative</td>
<td>If the patient’s creatinine is elevated then avoid metformin.</td>
<td>Ability to show an alert (on screen or paper)</td>
<td>% of metformin pts w/ high Cr.</td>
</tr>
<tr>
<td>Semi-structured</td>
<td>Lab value: creatinine</td>
<td>Clinical scenario: Elevated Cr… Action: avoid metformin</td>
<td>Lab results, medication list (database)</td>
</tr>
<tr>
<td>Abstract</td>
<td>LOINC 2159-2</td>
<td>if cr &gt; 1.2 mg/dL → Tell user “d/c metformin”</td>
<td>CIS with rule evaluation capability, alerting function</td>
</tr>
<tr>
<td>Machine interpretable</td>
<td>select * from labs where ID = 2159-2</td>
<td>If(cr&gt;1.2) → print(“d/c metformin”);</td>
<td>CPOE with lab, meds and alerting capability.</td>
</tr>
</tbody>
</table>
Partners CDS Services: CAD/DM Smart Form

Smart View: Data Display

Assessment and recommendations generated from rules engine

- Lipids
- Anti-platelet therapy
- Blood pressure
- Glucose control
- Microalbuminuria
- Immunizations
- Smoking
- Weight
- Eye and foot examinations

Smart Documentation

Assessment

No recent LDL measurement

Patient is on anti-platelet therapy

Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)

Patient is due for Pneumovax (older than 65, no record of prior vaccination)

Patient is due for Influenza Vaccine (high risk medical condition)

Patient may be Current Smoker, not thinking of quitting. Last counseled on 10/10/06.

Patient is overweight or obese (BMI 27.1 on 10/31/06, goal < 25)

Smart Assessment, Orders, and Plan
CAD/DM Smart Form

Rules
If patient has DM then goal BP < 130/80
If the average of the blood pressure at the last 2 visits (in the last year) is above goal then return..
CAD/DM Smart Form

**Medication Orders**

- 75 yo man with CAD, DM, and elevated CK. He is not having any of his medications. I last saw him 3 months ago.

**Lab Orders**

- **CAD-related**
  - Diabetes mellitus type 1
  - Coronary artery disease

- **DM-related**
  - Diabetes mellitus type 1

**Referrals**

- Onychomycosis
- Elevated creatine phosphokinase

**Handouts/Education**

- "Control High Blood Pressure"
- Print DASH diet instructions
- Print exercise "prescription"
## Accomplishments to Date

| KM Lifecycle Assessment Team | • Completed Knowledge Management and CDS Survey and sent it out to the Consortium sites. PHS and Regenstrief have returned the survey  
• PHS Site Visit, June 16-20. Interviewed and shadowed Partners physicians about their knowledge management and CDS practices  
• Site visits to Regenstrief and VA scheduled and shepherds identified |
| Knowledge Translation and Specification Team | • Completed semi structured representation and presented work to AHRQ and TEP on July 11, 2008.  
• Draft clinical action model developed. |
| KM Portal | • Delivered eRoom as a collaborative environment for CDSC activities and finalized KM Portal design hardware |
| Vendor Generalization and CCHIT Team | • Completed capability reviews of nine EHR systems through customer interviews to assess their decision support features. |
| CDS Services Development | • Completed literature review on current service-oriented architectures for clinical decision support.  
• Beginning service development. |
| Joint Information Modeling Working Group | • Patient data model and terminologies selected.  
• Developing conceptual model. |
## Timeline Overview

<table>
<thead>
<tr>
<th>Year I</th>
<th>Year II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Management Lifecycle Assessment</td>
<td></td>
</tr>
<tr>
<td>Knowledge Translation and Specification</td>
<td></td>
</tr>
<tr>
<td>Knowledge Portal &amp; Repository</td>
<td></td>
</tr>
<tr>
<td>CDS Web Services Development</td>
<td></td>
</tr>
<tr>
<td>Vendor Recommendation/CCHIT</td>
<td>Demo Phase 1: LMR</td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
</tr>
<tr>
<td>Dissemination</td>
<td></td>
</tr>
</tbody>
</table>
Questions & Answers

Our Panel

Jon White, MD
Agency for Healthcare Research and Quality

Richard Shiffman, MD, MCIS
Yale University School of Medicine

Blackford Middleton, MD, MPH, MSc
Partners Healthcare System
Save the Date!

Our Next Event

A National Web Conference on Use of Clinical Decision Support and Impact on Workflow

Second teleconference in our four-part series on Clinical Decision Support

October 27, 2008, from 2:30 pm – 4:00 PM Eastern Time

Watch your inbox for information on how to register
Thank You for Attending
This event was brought to you by the AHRQ National Resource Center for Health IT

The AHRQ National Resource Center for Health IT promotes best practices in the adoption and implementation of health IT through a robust online knowledge library, Web conferences, toolkits, as well as AHRQ-funded research outcomes.

A recording of this Web conference will be available on the AHRQ National Resource Center Web site in approximately one week.

http://healthit.ahrq.gov